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Pleasure or profit? Surveying the purchasing intentions of potential electric vehicle adopters in China

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Abstract: China is a leading global market for electric mobility, inclusive of e-bikes (motorcycles and scooters) as well as electric vehicles (EVs). This paper provides a novel contribution to the field by examining the factors related to willingness of potential Chinese consumers to further adopt EVs. Much of the research to date has focused primarily on consumer perceptions in European countries, or within particular cities or urban provinces of China. Given that China also is the largest greenhouse gas emitter in the world, and that transportation is growing in its contribution to China's national footprint, the potential for larger scale uptake of EVs by Chinese consumers is an important area of research. We therefore utilize a survey instrument among a fairly large national sample (805 respondents across all Chinese provinces) to solicit perceptions of Chinese consumers about their willingness to adopt EVs, and the importance of different types of motivations, controlling for socio-demographic variables. Using descriptive statistics as well as multivariate analysis and principal component analysis, we find that willingness to adopt EVs is associated with performance features of electric vehicles, the perceived benefits of driving an electric vehicle and policy support for the promotion of electric vehicles. We conclude by elaborating on the implications of our findings, namely insights for car dealerships and sales personnel, automotive manufacturers, local and national planners, and users and adopters.

Keywords: pro-environmental behavior; electric mobility; decarbonizing transport; electric vehicles; purchasing intentions

1. Introduction

A fundamental shift in passenger vehicles is needed to achieve forms of mobility that are most environmentally sustainable (as well as socially acceptable and just). According to the last assessment from the Intergovernmental Panel on Climate Change, approximately 14% of global greenhouse gas emissions can be attributed to the transportation sector (IPCC, 2014). One possible solution to help reduce global greenhouse gas emissions and air pollution is a large-scale shift to electric vehicles (EVs). However, the consumer uptake of EVs is relatively low globally, with the International Energy Agency (2018) reporting that only in one country, Norway, do EVs have a greater than 5% market share.

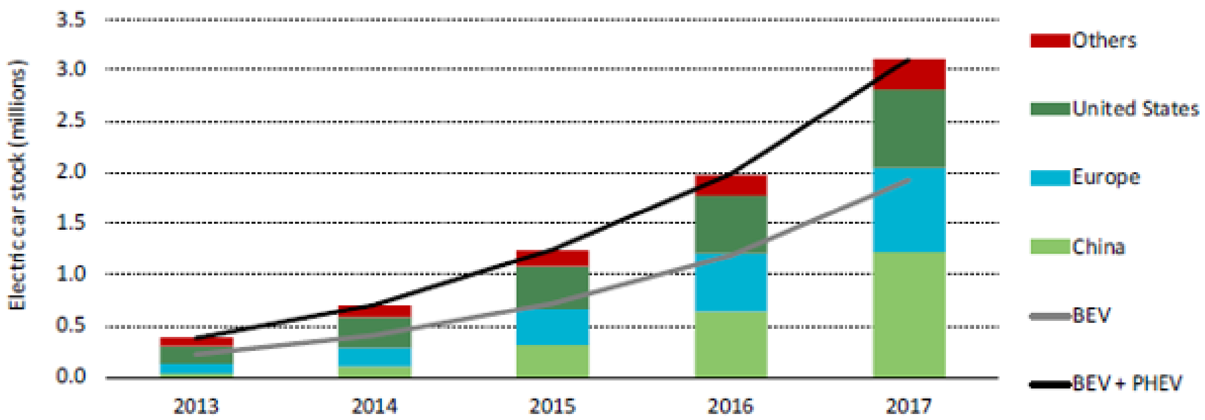
In the People's Republic of China (hereafter "China"), the world's largest developing country, total vehicle stock has risen from 23.8 million in 2003 to 194 million at the end of 2016 (Traffic Management Bureau of the Public Security Ministry, 2017), with an annual growth rate of 17.5%. At the same time, Chinese transportation-related GHG emissions continued their dramatic increase historically (Mao, Yang, Liu, Tu, & Jaccard, 2012). Carbon emissions from transport as a share of total emissions almost doubled, from 4.9% in 1995 to 8.6% in 2014, the latest data available from the World Bank (2018). Reducing transport emissions, in particular emissions of private vehicles, is a therefore key element for mitigating the risks of climate change (Berggren and Magnusson, 2012). Different scenarios for emission reduction (Leighty, Ogden, & Yang, 2012) indicate that electrification of vehicles, rapid improvements in vehicle efficiency, and low-carbon biofuels can help achieve high reductions in transportation GHG emissions.

Thus, promoting the uptake of EVs could contribute greatly to the reduction of urban air pollution and GHG emissions. With a booming economy and increased urbanization in China, the automotive market scale will continue to increase in the future, which will intensify the coupled issues of energy security and pollution. With its large population size and continuously rising disposable income, China has not only taken over the United States as the largest energy consumer and GHG emitter since 2009 (Liu, Geng, Lindner, & Guan, 2012), but also surpassed the United States as the world's largest automotive market that year (Schmitt, 2009). Consequently, there is an urgent need to promote EVs in China, which can help relieve the stress on fuel supply and contribute to a substantial reduction of GHG emissions.

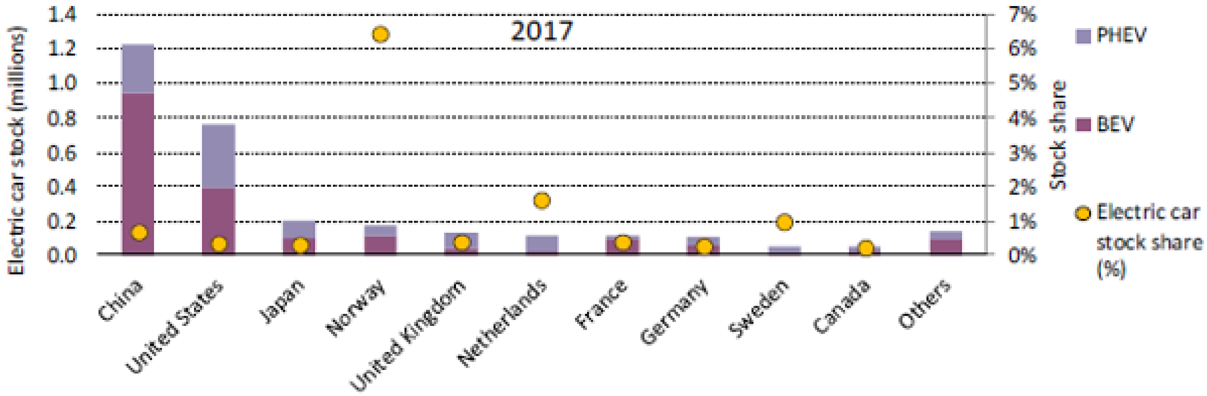
Because of these factors, China has already emerged to be a leading market for electric mobility. According to the International Energy Agency (2018), annual sales of new EVs—inclusive of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs)—exceeded 1 million units in 2017, the largest of any year yet. These sales figures represented a 54% growth rate over 2016, and resulted in a total global stock of more than 3 million vehicles. As Figure 1 reveals, more than half of global sales of such EVs—almost 570,000—were in China, where EVs had a market share of 2.2% in 2017. To put these numbers in perspective, the volume of EVs sold in China were more than double the amount sold in the next largest market, the United States.

Figure 1: Global and Chinese electric vehicle sales

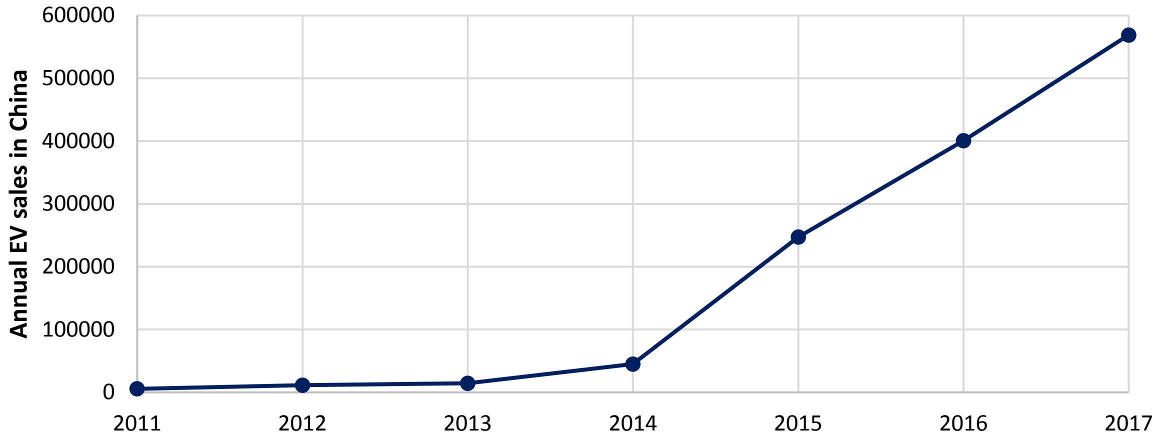
a. *Top panel: total electric car stock (millions), 2013-2017*



b. *Middle panel: Car stock and market share for selected countries, 2017*



c. *Bottom panel: Annual EV sales in China, 2011-2017*



Note: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Source: Modified from International Energy Agency (2018) and Lin and Wu (2018).

This paper aims to provide a novel contribution to the field by examining the factors related to willingness of potential Chinese consumers to further adopt EVs. Much of the research to date has focused primarily on consumer perceptions in European countries (e.g. Graham-Rowe et al., Schuitema et al., 2013; Sovacool et al. 2018) and the United States (Egbue & Long, 2012). Given that China is the largest greenhouse gas emitter in the world, the potential for even larger scale uptake of EVs by Chinese consumers is an important area of research. Previous work in China has for example focused on analysis of policy options to encourage the uptake of EVs, but so far, these policies are only one factor influencing consumer behavior (e.g., Zhang, Wang, Hao, Fan, & Wei, 2013).

By contrast, our paper aims to make both empirical and conceptual contributions. Empirically, our study looks only at passenger electric vehicles, rather than e-bikes or other

"New Energy Vehicles" more broadly, such as Lin et al. (2017), Lin et al. (2018), and Du et al. (2018). Second, it utilizes a national survey, rather than previous studies focusing only on particular provinces such as Tianjin (Du et al. 2018, She et al. 2017), subnational regions such as Jiangsu (Huang and Qian 2018), or urban areas such as Shanghai (Wang et al. 2018), Hefei (Han et al. 2017), Beijing, Shanghai, Guangzhou and Shenzhen (Lin and Wu 2018), or "pilot cities" (N Wang et al. 2017a; S Wang et al. 2017b). Third, it has a larger (and in a way more robust) sample size (805 respondents), greater by far than those studies with 324 respondents (Wang et al. 2017b), 348 (Huang and Qian 2018), 458 (Wang et al. 2018), 476 (She et al. 2017), and 607 (Han et al. 2017). As we explain below, importantly more than half of our respondents also had previous experience with an EV.

Conceptually, compared with much existing research, our study considered financial and other motivations that affect Chinese customers' willingness to adopt EVs. This is therefore one of the first studies with a large sample to better understand the crucial factors related to willingness to adopt EVs in China that tease apart the relative influence of different types of motivations. We proceed to analyze our survey data using descriptive statistics as well as multivariate analysis and principal component analysis.

2. Who cares about electric mobility? An overview of previous studies

Recent reviews of the literature have highlighted important and distinct motivators for people to adopt EVs and barriers that prevent people from doing so, although they tend to focus on Europe and North America and not Asia (e.g., Rezvani, Jansson, & Bodin, 2015 mention China only once, Sovacool et al. 2018 focus only on the Nordic region). However, such studies suggest that the adoption of new technologies such as EVs are generally associated with tradeoffs between high initial capital costs versus longer-term fuel efficiency.

Indeed, research findings suggest that common barriers to the adoption of electric vehicles are purchase price, lack of knowledge about cost, and cost savings of EVs compared to conventional vehicles, as well as perceptions (and misperceptions) about the risks of adoption such as range or charging. Table 1 offers an illustrative, but by no means exhaustive, list of barriers. A fairly recent review (Rezvani et al., 2015) distinguishes between different so-called “attitudinal factors” that affect consumer uptake of EVs. The review highlights the importance of financial motivation, such as people’s perceptions about ownership costs and the operational costs of EVs, as well as other motivations, such as consumer perceptions of policies to support EV uptake, and performance features of EVs. These motivations will be outlined further below.

Table 1: Illustrative summary of the barriers to EV adoption

Source	Central Barriers
(Sovacool and Hirsh 2009)	Price, consumer knowledge, institutional inertia
(Hidrue et al. 2011)	Range, Charging Time, Price
(Axsen and Kurani 2011)	Range, Public charging, Immature Technology, Price
(Egbue and Long 2012)	Range and price
(Flamm and Agrawal 2012)	Price, worse technology, charging infrastructure
(Graham-Rowe et al. 2012)	Price, performance, range, aesthetics, symbolic value
(Steinhilber, Wells, and Thankappan 2013)	Government policy, charging infrastructure, business models
(Schuitema et al. 2013)	Range, consumer perceptions
(Sierzchula et al. 2014)	Price (subsidies) and charging infrastructure
(Rezvani, Jansson, and Bodin 2015)	Consumer perceptions & knowledge, price
(Sovacool et al. 2017)	Uncoordinated policy mixes and transformative failures, consumer misperceptions
(Zarazua et al. 2018b)	Deceptive or dismissive sales tactics at automotive dealerships

Source: Compiled by the authors.

2.1 Financial motivations

The high upfront cost of EVs is commonly found to be a barrier to EV adoption among consumers (e.g. Caperello & Kurani, 2011; Graham-Rowe et al., 2012; Sovacool & Hirsh, 2009). Many authors suggest that EVs have perceived economic or utilitarian benefits such as cheaper “fuel” expenses compared to gasoline prices (Zhou et al. 2015; Kihm and Trommer 2014; International Energy Agency 2013; Green et al. 2011) or the fact that when connected to the grid EVs can become sources of income which provide energy storage or grid services (Galus et al. 2010; Wolsink 2012).

For example, a survey study by Bockarjova and Steg (2014) examined the factors related to intention to adopt EVs among a broadly representative sample of about 3,000 Dutch drivers. When people expected EVs to have higher monetary (e.g. purchasing cost) and non-monetary costs (e.g. long charging times) compared to conventional vehicles, people were less likely to want to adopt an EV.

A survey of car users in the United States (Egbue & Long, 2012) examined consumer perceptions and attitudes among a sample of 400 faculty, staff and students at a technological university that mainly specializes in science and technology programs. The study authors consider their sample to consist of what they refer to as “technology enthusiasts” (i.e., people with a keen interest in and knowledge of new technologies). Cost was ranked as one of the most important barriers to adopt EVs. The authors further suggest that early adopters (e.g. “technology enthusiasts”) will be more likely to adopt electric vehicles when they perceive them to be superior in performance compared with conventional vehicles.

A Chinese study (Zhang et al., 2013) of customers of car retail stores found that expected financial benefits (i.e. fuel cost, purchase price, maintenance cost and overall cost) was one of the key determinants of people’s stated preference for EVs. In a study on consumer adoption of hybrid electric vehicles (HEVs), Gallagher and Muehlegger (2011) found that consumers usually make the decision to buy HEVs in response to increase in gas prices and government incentives.

2.2. Social factors (attitudes, knowledge and policy support)

Other motivations include a range of factors, such as public support for policies to encourage EVs, knowledge about EVs, performance features of EVs and concerns about charging infrastructure and driving range.

To promote the adoption of EVs, governments around the world have implemented a series of supporting policies, mostly through financial incentives and the provision of charging infrastructure. Of these policy measures, subsidies on the purchase of EVs are viewed as being important to encourage adoption (Sierzchula et al., 2014). A number of studies have found that consumer subsidies on HEVs were positively associated with increased adoption rates (e.g., Beresteanu & Li, 2011; Gallagher & Muehlegger, 2011). Other studies have found that higher gasoline prices, not consumer subsidies, were related to increased adoption rates of EVs (Diamond, 2009).

Consumer preferences about technical features, such as charging facilities, the reliability of electric vehicles, or environmental attributes of EVs (e.g. reduced pollution) also determine decisions to adopt. For example, intentions to adopt were positively associated with levels of perceived self-efficacy (i.e. ability to make use of charging facilities, ability to use alternative mode of travel for longer distance journeys) (Bockarjova & Steg, 2014). Sovacool et al. (2018) explored how demographic attributes (gender, age, income) impacted EV preferences in the Nordic Region. They found that the market segments most willing to adopt EVs were (1) men with higher levels of education in full time employment, especially with occupations in civil society or academia, and below middle age (30–45), (2) higher income females and (3) retirees/pensioners.

Other studies have examined the importance of symbolic or social attributes of new technologies such as EVs (e.g., Graham-Rowe et al., 2012; Schuitema et al., 2013; Nayum &

Klöckner, 2014; Noppers et al., 2015; Sovacool and Axsen 2018). Symbolic attributes refer for example to the status associated with ownership of electric vehicles (e.g. that its owner cares about the environment, or that its owner is "making a difference"). A study of about 2,700 car owners in the UK (Schuitema et al., 2013) found that symbolic attributes played a role in intentions to adopt EVs. Other research has confirmed that automobile preferences in particular relate to a constellation of norms, interpersonal judgments, or affirmation of identity (Barbarossa, Beckmann, De Pelsmacker, Moons, & Gwozdz, 2015). Another strand of research finds that that EV adoption affirms lifestyle identities related to sustainability or innovativeness, such as being "green" or labelled an "early adopter" (Kahn 2007; Graham-Rowe et al. 2012; Schuitema et al. 2013; Sovacool and Blyth 2015), or even notions of security and "cocooning" found in larger vehicles (electric and non-electric), enabling cars to insulate occupants from otherwise noisy or unpleasant aspects of daily life (Wells and Xenias 2015). Then come those studies concluding that broader images or symbolism related to confidence in industrial competitiveness, nationalism, security, responsibility or environmentalism affect EV preferences (Axsen and Kurani 2003; Graham-Rowe et al. 2012; Melton et al. 2016). Another body of evidence emphasizes the importance of factors such as "interpersonal influence" and social networks as they relate to EV acceptance (Axsen et al. 2013; Axsen and Kurani 2011; Axsen and Kurani 2012; Axsen and Kurani 2013; McCoy and Lyons 2014).

A final collection of research holds that the act of driving is a profoundly social process—one that both shapes and is shaped by norms, attitudes, and practices (Sovacool 2017). These include the services that automobiles provide drivers, such as desire for solitude, personal security, speed, and freedom. It also encompasses the interlinkages that automobiles have with other aspects of social or cultural life, such as commuting to work, eating food, or taking a vacation (Cohen 2006). Automobiles can lastly become an important status signal, signifying or symbolizing wealth or masculinity (Walker et al. 2000). Because drivers invest emotionally as well as economically in their cars, cars create affective contexts that culminate in “the joy of driving.” To be sure, this “joy” need not always be based in utilitarian calculations; in some instances it can be an amalgamation of aesthetics, sensory responses, and notions of social or environmental sustainability (Sheller 2004; Ryghaug and Toftaker 2014). Under this view, EVs exist as part of a complex and dynamic system of automobility that fuses together financial and other symbolic and affective components.

3. Research methods and analytical framework

In this study, based on the overview of literature above, we examine the relative importance of different types of motivations—financial, symbolic, social, etc.—in a Chinese context. These motivations include cost considerations, policy support, charging facilities, knowledge, and performance features of electric vehicles in explaining consumer willingness to adopt EVs. We expect that each of these features will uniquely contribute to the explanation of consumer willingness to adopt EVs. We control for socio-demographic variables because previous research has found these variables to be related to intentions to buy electric vehicles (e.g., Nayum, & Klöckner, 2014). Through an exploratory analysis, we examine whether the socio-demographic variables moderate the relationships between each motivation and willingness to adopt EVs.

We defined EVs as any passenger vehicle that uses energy drawn from the electric grid and stores it on board for propulsion (She et al. 2017). In China, EVs broadly fall under the term “New Energy Vehicles” and therefore receive a credit mandate that sets minimum requirements for manufacturers to produce PHEVs, BEVs, and fuel-cell electric vehicles (FCEVs) (International Energy Agency 2018). Our definition thus includes BEVs, PHEVs, FCEVs and range extended electric vehicles (REEVs) (Du et al. 2018; Du et al. 2017; Schneidereit et al. 2015), but not other “New Energy Vehicles” such as e-bikes or those relying on biofuel or hydrogen exclusively. Although motivations and barriers for BEVs, PHEVs, FCEVs, and REEVs may differ, we have treated them as a single class of “EVs” because that is often how they are discussed in the popular press and marketing materials.

3.1 Participants and procedure

Our primary data collection tool was a survey consisting of three sections and 17 questions. The first section asked for demographic and background data of respondents; the second section asked about travel patterns and potential willingness to adopt an EV; the third section about awareness and knowledge of EVs. Appendix I shows the full survey as distributed in Chinese, Appendix II the English translation (used only here—the survey was only distributed in Chinese). The survey was designed to take roughly five to ten minutes to complete.

The survey was distributed throughout China between April and August in 2016 across all 23 Chinese provinces, four municipalities (Beijing, Tianjin, Shanghai, Chongqing), five autonomous regions (Guangxi, Inner Mongolia, Tibet, Ningxia, Xinjiang) and two special administrative regions (Hong Kong, Macau). It was distributed through an internet survey platform, whose users and respondents were mainly academic staff or those with a higher educational profile. In doing so, we aimed for a purpose sample rather than a random or representative sample, aiming to get as many respondents that had actual experience with an EV. As both Sovacool et al. (2018) and Rezvani et al. (2015) argue, one drawback to many existing surveys of EV attitudes is they recruit random participants who have no direct experience with EVs, potentially biasing their results, or at least limiting their validity. Our survey was voluntary, and no incentives were provided to the participants.

3.2 Measurement of variables

We analyzed survey results according to seven variables: cost considerations, policy support, performance features of EVs, charging facilities, knowledge, willingness to adopt an EV, and past experience with EVs.

Cost considerations. People were asked to indicate how important four aspects related to cost would be in their decision to adopt an electric vehicle (1 = extremely unimportant to 5 = extremely important). These aspects were: purchasing cost, fuel cost, maintenance cost, and depreciation.

Policy support. Participants were presented with four policy options to encourage consumer uptake of EVs and they were asked to indicate how important each of these would be in their decision to buy an EV (1 = extremely unimportant to 5 = extremely important): direct government subsidies (e.g., a rebate); low interest loans; tax exemptions and reductions; ease of registration (this refers to easier access to obtain license plates; in some large Chinese cities, owners of gasoline vehicles can only obtain plates through a lottery system).

Performance features of EVs. Participants were presented with a list of nine performance features of EVs: driving range, driving speed and acceleration, battery life, design, size and comfort, ease of operation, safety, reliability of technology, financial savings (cheaper to drive), and environmental attributes (avoiding air pollution and GHG emissions). Participants were asked to indicate how important each of these features would be in their decision to adopt an electric vehicle (1 = extremely unimportant to 5 = extremely important).

Charging facilities. Three specific questions were asked about issues related to charging of the vehicle. Again, participants were asked to indicate how important these would be in their decision to buy an EV, on a scale from 1 = extremely unimportant to 5 = extremely important.

Knowledge. Participants' self-assessed knowledge about EV was measured by asking how much they felt they knew about EVs and then asked how much they felt they knew about the government's policies on EVs – both with the answering options 1 = "practically nothing", 2 = "only a little", 3 = "a fair amount", and 4 = "a lot".

Willingness to adopt an EV was assessed by asking participants: "Compared with the traditional (internal combustion engine) vehicles, would you rather like to buy an electric vehicle?" (1 = strongly disagree and 5 = strongly agree).

Past experience with EVs. To control for prior experience driving an EV, people were asked to indicate whether they had previously driven an electric vehicle. This variable was entered as a covariate, as prior research on travel mode choice suggests that past behaviour is predictive of intentions and future behaviours (Verplanken, Aarts, & Van Knippenberg, 1997).

3.3 Limitations

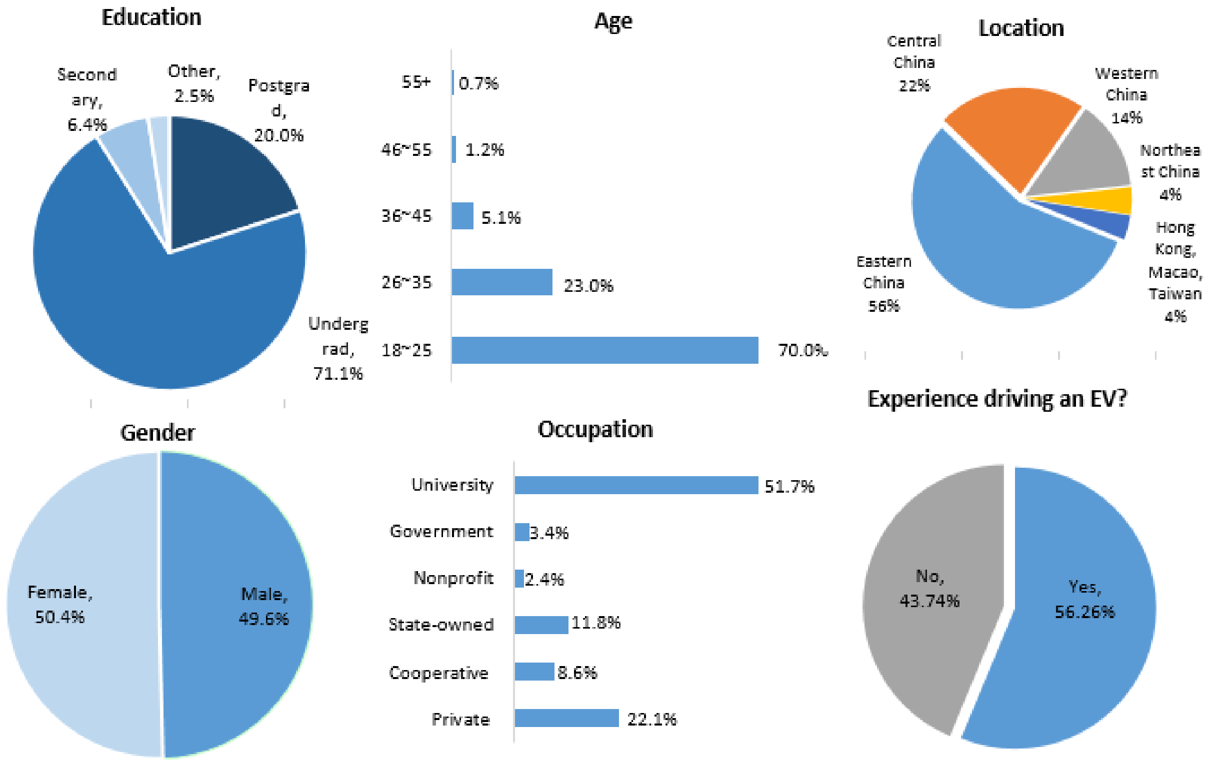
Admittedly, our procedure and measurement of variables has a number of limitations. We did not offer respondents any information about EVs (including a definition of what they are) before taking the survey, as our intent was to test their views without shaping their predetermined knowledge. However, this could have given rise to mixed interpretations about what EVs are. For the reason explained above, we sought a purposive sample of those with more experience of EVs rather than a purely random sample (which, as we report below, we achieved). We utilized a survey design with ratings of importance, rather than continuous variables or a stated preference choice experiment. We treated "EVs" as a single entity, when in fact important differences do exist between BEVs, PHEVs, FCEVs, and REEVs.

We used a self-assessed measure of knowledge, which did not meet acceptable levels of construct validity. Relatedly, we only distributed the survey instrument once. This is a weakness especially given that research has shown that preferences for an EV can change significantly *after* potential adopters gain experience with them (Jensen et al. 2017), a problem that can be addressed by "long panel" approaches that interview or survey people before and after experience with an EV (Jensen et al. 2014). In addition, it would have been preferable to include a set of multiple choice questions about various performance aspects of elective vehicles and a summed total of correct answers could have been used as an indication of knowledge. The question also included an "I don't know" option, which resulted in excluding some participants in the regression analyses. However, we ran the regression with and without these participants and the results were broadly similar. This suggests that this attrition did not affect the main findings. Lastly, the study included a measure of willingness to adopt electric vehicles, which may or may not translate into actual adoption of EVs. Future work could include additional follow-up measures of for example EV uptake over time as part of a longitudinal survey.

4. Results

We received initial survey responses from 1038 participants, after which we reduced to 805 valid responses due to repetitive and incomplete surveys, or those who completed the survey too quickly (in less than a minute, suggesting disingenuous responding). Among the valid responses, Figure 2 shows that more than half (56.1%) come from Eastern China, which is among the most populous, followed by Central China, with a proportion of 22.5%, and Western China, with 13.6% (matching roughly population distribution). In terms of socio-demographic composition, about 50.4% of participants were female. The sample has an overrepresentation of the highly educated, with 71% of participants having an undergraduate degree, and 20% a postgraduate degree. Some 6.4% of participants have a secondary school or high school diploma. The sample is also relatively young, compared to the population average. About 70% is between 18 and 25 years of age, 23% between 26 and 35 years, and 5% between 36 and 45 years, and some 2% are 46 or over. About half work in academia (51.7%) and 22% in the private sector; the remainder of participants work in government, state-owned enterprises, cooperatives, or the non-profit sector. Critically, as a strength, more than half respondents (56.2%) did report having experience driving an EV.

Figure 2: Demographic profile of Chinese EV survey respondents (n=805)



Source: Authors

We then analyzed survey results according to our seven variables (cost considerations, policy support, performance features of EVs, charging facilities, knowledge, willingness to adopt an EV, with prior experience with EVs as a covariate) via descriptive statistics, multivariate analysis, and principal component analysis (PCA). Here we report our specific results as well as our regression and PCA results.

4.1 Results for specific variables

Cost considerations. Purchasing cost, fuel cost, maintenance cost, and depreciation formed a reliable scale with a Cronbach's alpha of .78 (M = 3.8; Sd = .76).

Policy support. Direct government subsidies (e.g., a rebate); low interest loans; tax exemptions and reductions; and easy access to registration for green vehicles formed a reliable scale (Cronbach's alpha = .77) and were combined to form a measure of the importance of public policies in encouraging EV adoption (M = 3.4; Sd = .78).

Performance features of EVs. Across the nine performance features of EVs, to explore the underlying dimensions, a Principal Component Analysis (PCA) was conducted with Varimax rotation. Two factors with eigenvalues greater than 1 were extracted, explaining 59% of the variance. The first factor (47% of the variance; eigenvalue of 4.26) included: ease of operation, safety, reliability, monetary savings, and environmental attributes (with factor loadings ranging from .67 to .73). The items combined formed a reliable scale (Cronbach's alpha = .80; Mean = 3.9; SD = .72). This variable was labelled "benefits of driving an EV." The second factor (11.8% of the variance, eigenvalue of 1.10) referred to driving range, battery life and speed (with factor loadings ranging from .63 to .83). These three items formed a reliable scale with a Cronbach's alpha of .70 (M = 3.6; SD = .82). This variable was labelled "performance features of EVs." The item "design, size, and comfort" loaded highly on both factors (.57 on the first and .44 on the second factors; (>.30 on more than one factor is considered a cross-factor loading; see Fabrigar et al., 1990). This cross-factor loading may be explained by the fact that that particular item included multiple features and not all of these features may have been equally important to people. Because of the possible ambiguity of the item, it was omitted from further analysis (see Osborne & Costello, 2009).

Charging facilities. Accessibility of charging service, ease of charging and charging time formed a reliable scale with a Cronbach's alpha of .79 (M = 4.0; Sd = .83).

Knowledge. The option "don't know" was coded as a missing value (74 participants, or 7%, indicated they didn't know how much they knew about EVs and 195, or 19% of participants didn't know how much they knew about the government's policies about EVs). It appears that self-assessed knowledge ratings were not very high in this sample, suggesting that participants knew 'only a little' about EVs (M = 1.8; Sd = .72) and of government policies (M = 1.5; Sd = .71) to encourage EV adoption. The measure of the two knowledge questions combined had a Cronbach's alpha of .64 – this is below the level generally considered acceptable (.70). We retained the combined knowledge scale, but we interpret the results with some caution. People who either answer "don't know" to one or to both of the knowledge questions were not retained in the regression analyses. This attrition due to missing values was significantly associated with gender (Chi square (1) = 5.423, $p < .05$): female participants were more likely to have indicated that they didn't know (and dropped out of the analyses) than male participants. Attrition was negatively associated with support $F(1, 1036) = 4.34$, $p <.05$), with those who dropped out expressing lower support for EV policies ($M = 3.3$ versus $M = 3.5$). Attrition was also significantly associated with the outcome variable: participants who were not included in the analyses had significantly lower scores on willingness to buy an electric vehicle (M = 3.2; SD = .96 versus M = 3.4, SD = .81). Attrition was not significantly associated with any other socio-demographic or independent variables. We conducted the regression analyses with and without the knowledge construct and apart from small changes to the regression weights, the results were broadly similar.

Willingness to adopt an EV. A total of 2.8% strongly disagreed with this statement; 11% fairly disagreed; 38.9% neither agreed nor disagreed; 42.6% fairly agreed, 4.7% extremely agreed. This was used as the outcome variable. On average, participants seemed neutral as to whether they would prefer an EV or a conventional car (M = 3.4; Sd = .84).

4.2 Descriptive statistics and correlations

Table 3 lists the descriptive statistics and correlations between the dependent and independent variables, showing how our analysis progressed stepwise over different models, an approach common in other studies of adoption and behavior (e.g. Bockarjova and Steg 2014; Huibin et al. 2018; Han et al. 2017; Wolf and Seebauer 2014). What becomes evident is that the benefits of EVs (e.g. reliability, environmental attributes) (M = 3.9; SD = .70) and aspects related to charging facilities for EVs (M = 4.0; SD = .80) were rated as most important in people's decision to adopt EVs, followed by the importance ratings of cost considerations (M = 3.8; SD = .74). These three variables were also most strongly correlated with willingness to adopt EVs. Higher importance ratings of the benefits of EVs (r = .30), cost considerations (r = .25), charging facilities (r = .24), performance features of the EV (r = .22), and policies to support EV adoption (r = .18) were all associated with stronger willingness to adopt EV. The covariate, prior and current use of electric vehicles was weakly associated with willingness to adopt EV: people who had used an EV or were currently driving one had a stronger willingness to adopt EVs (r = .09). Interestingly, knowledge did not appear to be significantly associated with willingness to adopt EVs.

Table 3. Descriptive statistics for the dependent and independent variables (N = 805)

	M	Sd	1	2	3	4	5	6	7
1. Willingness to adopt EV	3.4	.81							
2. Prior experience with EVs	n/a	n/a	.09*						
3. Performance features	3.6	.82	.23**	.05					

of EVs									
4. Benefits of EVs	3.9	.70	.30**	.01	.61***				
5. Cost considerations	3.8	.74	.28**	-.05	.45***	.68***			
6. Policy support for EVs	3.5	.75	.19**	-.03	.27***	.45***	.55***		
7. Charging facilities	4.0	.80	.23**	-.04	.50***	.63***	.60***	.50***	
8. Knowledge	2.0	.56	.07	.09**	-.02	-.10**	-.06*	.07*	-.04

Note: The numbers in the top row correspond to the numbers in the first column. Prior experience with EVs was measured with a yes / no answer; "not driven an EV before" was coded 0 and "driven an EV before" was coded 1. Variables 3-7 were measured on a scale from 1 = 'extremely unimportant' to 5 = 'extremely important'. Variable 8 was measured on a scale from 1 = "practically nothing" to 4 = "significant."

4.3 Regression results and interaction effects

To examine the predictive ability of the independent variables in explaining willingness to adopt EVs, a stepwise hierarchical regression analysis was conducted. First, to control for socio-demographic variables, education level, age, gender and household size were entered as covariates. Then, to control for past behavior, previous experience with EV ("driven an EV") was entered as a covariate. Then, the importance ratings of various aspects were entered (performance features, benefits, cost considerations, policy support, charging facilities), as well as self-assessed knowledge levels. Finally, the interaction effects between socio-demographic variables and motivations were entered. Table 4 lists the regression results (for an overview of the regression results at each of these steps, see Appendix III).

Table 4 Regression results with willingness to adopt EV as dependent variable (N = 805)

R	R^2	F		β (t)
.39	.15	4.01***	Age	.01 (.04)
			Gender	.04 (.16)
			Hh size	-.02 (-.10)
			Education	.16 (.67)
			Prior experience with EVs	.08 (2.32)*
			Cost considerations	.65 (1.86)
			Performance features	.53 (1.97)*
			Benefits of EVs	-.33 (-.88)
			Policy support for EVs	.03 (.10)
			Charging facilities	-.26 (-.81)
			Knowledge	.09 (.40)**
			Hh size * performance feat.	-.55 (-2.09)*
			Education * cost	-.65 (-2.01)*

Socio-demographic variables explained only 1.7% of the variance in willingness to adopt EV: (R = .13, R^2 = .017; F (4, 800) =3.52, p < .01). Willingness to adopt EVs was positively associated with household size (β = .09, t = 2.41, p < .05) and negatively associated with age (β = -.08, t = -2.34, p < .05), suggesting that people who were part of larger households expressed a stronger willingness to adopt EVs and older participants expressed a lower willingness to adopt EVs. Gender and education level were unrelated to willingness to adopt EVs.

Prior experience with EVs significantly added to the explanation of willingness to adopt EVs: R = .16; R^2 = .03; F_{change} (1, 799) = 5.96, p < .05. When socio-demographic variables were controlled for, willingness to adopt EV was positively associated with prior experience with EVs (β = .09, t = 2.44, p < .05): people with prior experience expressed a stronger willingness to adopt EVs.[1]

[1] On this point, we must admit that there is a possible issue of cause and effect about previous EV experience. It could be that people who sought out experiences with EVs already had more positive views about them. Indeed, their positive views may have lead them to try an EV, rather than any level of previous experience.

Importance ratings of various aspects of EVs significantly added to the explanation of willingness to adopt EVs: $R = .35$; $R^2 = .13$; F_{change} (6, 793) = 15.09, $p < .001$. When the other variables were controlled for, participants who attached more importance to the benefits of driving an EV (e.g. reliability, environmental attributes) expressed a stronger willingness to adopt EVs ($\beta = .15$, $t = 2.75$, $p < .01$). Cost considerations (e.g. purchasing price) were also positively associated with willingness to drive EVs ($\beta = .14$, $t = 2.69$, $p < .01$). Higher self-assessed knowledge was positively associated with EV uptake ($\beta = .10$, $t = 2.73$, $p < .01$). The importance of policies to encourage EV uptake, charging facilities, and performance features of EVs were unrelated to willingness to adopt EVs, when the other variables were controlled for.

Lastly, we examined whether socio-demographic variables moderate the relationship between each motivation and willingness to adopt EVs. In total, 24 interaction terms (4 socio-demographic variables times 6 motivations) were added to the regression. The addition of these interaction effects did not significantly add to the explanation of consumer willingness to adopt EVs ($R = .39$; $R^2 = .15$; F_{change} (24, 769) = 1.12, *ns*). There is some indication that household size moderates the relationship between consumer ratings of performance features and willingness to adopt EVs ($\beta = -.55$, $t = -2.09$, $p < .05$) and that level of education moderates the relationship between cost considerations and willingness to adopt EVs ($\beta = -.65$, $t = -2.01$, $p < .05$). But, the overall F-change was not statistically significant, which suggests that these interaction effects did not add significantly to the proportion of explained variance in willingness to adopt EVs, and therefore some caution is warranted in interpreting these findings.

There is the potential for confusing causality in our study since attitudes towards EVs were not directly measured before and after experience.

5. Policy implications

Clearly, although financial considerations play a meaningful role in decisions to consider adopting EVs in China, social factors such as attitudes, knowledge, and policy support also matter. To offer a brief summary of our results, considerations of cost and perceived benefits of EVs do matter and relate to willingness to adopt. People who have previously experienced an EV are far more likely to be disposed to want to drive or adopt one. Socio-demographic dimensions such as age and household size also shape intentions, albeit less so when cost and other variables are added to the model.

These findings suggest that marketing, industry, and policy strategies be altered across at least four important stakeholders: car dealerships, automotive manufacturers, policymakers and planners, and users and adopters. Table 5 presents a high-level overview of our fourteen recommendations for these four stakeholder groups.

Table 5: Recommendations for Chinese automotive dealerships, manufacturers, and policymakers

Stakeholder	Policy recommendations
Car dealerships and sales franchises	Include more demonstrations and test drives
	Develop and implement training schemes for all staff at car dealerships to foster the interaction with EV technology and vehicle options, focusing beyond financial motivations
	Revise sales schemes and commissions to favor EVs
Automotive manufacturers (OEMS)	Improve marketing and promotion campaigns
	Change the type and scope of EV documentation and work with motoring associations
	Emphasize benefits of EVs such as acceleration, comfort, luxury or safety
	Also focus on demonstrations and test drives (perhaps at expos and roadshows)
National and local policymakers	Policies need to reduce the capital cost of EVs (or increase the cost of conventional vehicles) to ensure better parity
	Stimulate research and innovation and

	stablish funds, competition, or challenges to overcome prominent technological barriers
	Promote more demonstrations and test drives, since experience with an EV is correlated with higher adoption preferences
	Mandate EV usage in taxis and other fleets
	Focus more on home charging, rather than expanding the existing network of public electric vehicle charging stations
Users and adopters	Can be targeted and incentivized with purchase subsidies and tax incentives
	Emphasize or mandate social privileges such as license plates, special lanes, free or reduced charging, and parking

Source: Authors

5.1 Car dealerships and sales personnel

Unless a potential adopter already has experience with an EV, their first encounter will likely be at a car dealership, where sales personnel serve as an important intermediary influencing consumer choices and purchasing patterns (Zarazua et al. 2018b). Given our findings that experience driving an EV seems positively associated with intentions to adopt an EV, more effort should be put into roadshows, test drives, and demonstrations.

Moreover, dealerships should develop and implement training schemes for all staff that emphasize financial *and other* social and policy considerations that seem to influence favorable patterns of EV adoption. This training should not be limited to specialized sales personnel.

Sales commission schemes (which could include sales competitions or bonuses) could also be revised to make an EV equally – if not more – attractive to sell, than petrol or diesel options. As we elaborate below, this can be harmonized both with industry/OEM incentives as well as broader national policy architectures.

5.2 Automotive manufacturers

Our findings suggest that the broader automotive industry may also need to change some of their strategies and marketing approaches. Promotional campaigns should be developed to communicate the benefits, specifications and availability of EVs to franchise dealerships. Similar to our suggestions to dealerships, these messages and materials should not focus exclusively on the financial or even environmental attributes of EVs, but also on elements of superior performance, such as ease of operation, luxury, comfort, acceleration and safety.

National motoring associations, such as consortia of “4S” shops undertaking automotive sales, spare parts, service, and surveys or the China Association of Automobile Manufacturers, could publish electric vehicle guidance for sellers, dealers and auction houses. In addition, OEMs could also explore changes to the documentation that is handed to new owners when a vehicle is sold, to include financial and other specifications of EVs.

Interestingly, knowledge did not appear to be significantly associated with willingness to adopt EV, whereas experience with them was—hence moving beyond informational materials to the importance of experiential “events” such as test drives and demonstrations. These could in particular be done in tandem with dealerships, or at automobile expos and roadshows.

5.3 Local and national policymakers

Given the confirmed significance of financial motivations in Chinese customers’ willingness to adopt EVs, the clearest path towards accelerated diffusion appears to be policy mechanisms that reduce the capital cost (or operating/charging cost) of EVs, as well as the cost of major equipment such as batteries. The rising middle class in China, a large market of potential adopters, seem (understandably) sensitive to vehicle price.

Furthermore, however, our sample of respondents discussed the importance of reliability and performance of EVs, such as the safety, operation, as well as economic and environmental attributes. Therefore, more efforts should focus on innovation and improving research and development (R&D). For example, giving more tax reduction to enterprises to encourage their R&D investments and activities, or setting up specific research funds, competitions, missions or challenges to overcome prominent technological barriers. Such efforts, especially when done in concert, can enhance consumer confidence in EV technology and better synergize with the suggestions made above to dealerships and manufacturers.

As mentioned above, another policy implication could be more targeted campaigns of test-driving and demonstration, which could prove an important motivating factor for potential electric vehicle buyers. In fact, China has already conducted EV demonstrations for several years, and they have had a positive impact on public perceptions. However, these demonstration activities have mainly been focused on electric buses, meaning private electric vehicles remain somewhat mysterious to many customers. (Even in our highly educated sample of respondents, almost half of respondents had no experience driving an EV). As such, more test driving activities should be conducted—and sponsored by governments in association with dealerships or OEMs—that help customers gain accumulated experience with EVs. In addition, EVs could be promoted (or even mandated by local statute) as taxis in urban areas, or utilized in ride sharing platforms and new business models looking at mobility as a service.

Curiously, our regression analysis implied that charging networks were unrelated to willingness to adopt, when other variables were controlled for. This suggests that perhaps less policy emphasis be placed on public charging, and more emphasis on home charging (as consumers may simply presume they can charge their vehicle at home) as well as test drives. Or, in line with Noel et al. (2019), perhaps it suggests that range anxiety (fear about lack of charging) is not as salient a barrier as previously anticipated in the literature. We can only offer speculation on this point as our survey instrument did not distinguish between public and private (home) charging—it only asked about charging service accessibility, ease of charging and charging time. Future research ought to explore more public perceptions and preferences for home and public charging.

5.4 Users and adopters

Our final two recommendations focus on users themselves, who Styczynski and Hughes (2018) emphasize must be part of any typology of policies aimed to accelerate EV adoption. On the financial side, purchase subsidies and tax incentives could motivate consumers driven by economic calculations to more seriously consider EVs. On the social side, special EV license plates, preferential lane access for EVs, free or cheap charging, and parking privileges could motivate consumers driven by attitudes, values, and the symbolic aspects of electric mobility. In their work on EV adoption and policy in the Nordic region, Kester et al. (2018) confirm that such non-financial incentives—free or recued parking, access to bus lanes, free charging, exemptions on toll roads—are important factors shaping the public acceptability of EVs.

6. Discussion and conclusion

By conducting this survey about what Chinese consumers think about EVs, and analyzing the results of our regression analysis and principal component analysis, we offer multiple conclusions.

Firstly, our data supports the contention that Chinese consumers have strong preferences about the perceived benefits of driving an EV (e.g. reliability) and the related costs when they think about purchasing electric vehicles. This is broadly in line with previous work in this area from other countries (e.g. Caperello & Kurani, 2011; Graham-Rowe et al., 2012;

Sovacool & Hirsch, 2009). But these preferences were not all associated with intentions to adopt electric vehicles. Our regression analysis suggests that while cost considerations and the perceived benefits determined willingness to adopt electric vehicles, importance ratings of charging facilities were unrelated to willingness to adopt – when all other variables in the model were controlled for. This finding is in contrast with previous research, suggesting that consumer preferences about charging facilities were associated with intentions to adopt an electric vehicle (Bockarjova & Steg, 2014). One explanation could be consumers presuming they could charge at home, or that vehicles had adequate range to meet their daily commuting needs without public charging.

Secondly, we find that people who have more experience with EVs are more likely to want to own or drive an EV, whereas knowledge did not appear to be significantly associated with willingness to adopt EVs. Self-assessed knowledge was weakly associated with customers' willingness to adopt EVs. Previous research indicates that knowledge is an important predictor of willingness to adopt EVs (e.g., Rezvani, Jansson, & Bodin, 2015); however, we only found a small association between the two. This may be due to the way knowledge was measured in this study, which reflected self-assessed knowledge rather than actual knowledge. If accurate, however, the implication here is clear: focus less on information in EV promotion, and more on demonstrations and test drives.

Thirdly, some socio-demographic variables (age and household size) do significantly influence purchasing intentions. However, when cost considerations and other motivations were added to the model, these socio-demographic variables have a more limited relationship with consumer decisions. Other motivations (performance features of electric vehicles, and policy support) appear to be more positively associated with willingness to adopt EVs (see also Graham-Rowe et al., 2012). Contrary to previous research (e.g. Nayum & Klöckner, 2014; Sovacool et al. 2018), socio-demographic variables do not predict consumer willingness to adopt electric vehicles when other motivations are controlled for. For example, our results suggest that gender and education level are unrelated to willingness to adopt EVs. This may be reflective of our sample being relatively young, highly educated and having a relatively high income. Studies with more broadly representative samples could shed more light on whether our current findings extend to the wider Chinese population.

Fourthly, in terms of policy implications, cost considerations are an important factor in the willingness for Chinese consumers to adopt EVs, but not for everybody all the time. Indeed, when cost considerations are not important, consumer perceptions about the features of electric vehicles, benefits of electric vehicles and policy support for electric vehicles come into play. Hence our recommendations that dealerships train sales personnel to emphasize the broad range of EV benefits to possible adopters, not just financial or environmental ones; that manufacturers change their marketing campaigns and printed materials relating to EV advertising and sales documents, and focus more on demonstrations and test drives; and that local and national policymakers focus on further reducing the cost of EVs, promote more demonstrations, and perhaps emphasize the reliability of home charging over public charging infrastructure (among other suggestions). Users and adopters themselves can be stimulated to adopt EVs by targeted purchasing incentives (to reduce cost) as well as social privileges (such as license plates and parking). This underscores the necessity of holistic action among at least four influential stakeholder groups: car dealerships and franchises, automotive manufacturers, local and national policymakers, and adopters. It also suggests that interventions may need to be targeted at different consumer groups if the aim is to achieve a large-scale shift in the further and continued uptake of electric vehicles.

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